Asian Journal of Biomedical and Pharmaceutical Sciences
ISSN : 2249 - 622X

RESEARCH ARTICLE

literati Open Access
rapid dissimination of knowledge

Received on: 05-11-2013
Accepted on: 22-12-2013
Published on: 18-01-2014

Nwankwo Emmanuel*
[a]Specialist Hospital, Lokoja, Kogi State, Nigeria.
Email: emmaonwubiko@yahoo.com
Telephone: +2348023309146

QR Code for Mobile users

Conflict of Interest: None Declared !

Evaluation of Efficacy of Disinfectants Using Standard Methods in Healthcare Facilities in Kogi state, Northcentral Nigeria

E Akabueze Elias[a], Obi Samuel[b], Nwankwo Emmanuel[a*], Ojoru Abraham[a]
[a]Specialist Hospital, Lokoja, Kogi State, Nigeria
[b]Department of Microbiology Faculty of Natural sciences, Kogi State University, Anyigba, Kogi State, Nigeria

Abstract

Background: Disinfectant failure could increase microbial load on fomites and predispose patients to nosocomial infection. The aim of this study was to evaluate the efficacy of disinfectants using standard methods in hospitals in Kogi State.

Materials and methods: Dettol and Izal which are phenolic disinfectants were evaluated for efficacy against phenol using locally isolated multidrug resistant *Pseudomonas aeruginosa* as test organism in randomly selected hospitals in Kogi state between November 2011 to June 2012 Standard method of Rideal-Walker, Chick-Martin and capacity test of Kelsey-Sykes were used.

Results: The Rideal-Walker coefficient for izal and Dettol were 2.5 and 3 respectively while Chick-Martin coefficient for izal and dettol were 2 and 2 respectively. Capacity test of Kelsey-Sykes also showed satisfactory results at first 2 concentrations used for both disinfectants.

Conclusion: The disinfectants tested were considered effective for use in the health care facilities.

Keywords: Phenolic disinfectant, efficacy, Rideal-Walker, Chick-Martin, Kelsey-Sykes.

Cite this article as:
E Akabueze Eliasa, Obi Samuelb, Nwankwo Emmanuela*, Ojoru Abrahama. Evaluation of Efficacy of Disinfectants Using Standard Methods in Healthcare Facilities in Kogi state, Northcentral Nigeria. Asian Journal of Biomedical and Pharmaceutical Sciences; 03 (27); 2013; 34-38.

INTRODUCTION

Appropriate disinfection and sterilization procedures are a must for control of hospital-acquired infection. Disinfection in hospital practice is mainly achieved either by surface disinfection (e.g., disinfection of surfaces of the tables, trolleys, instruments, walls and floors, etc.) or immersing the contaminated objects in the disinfectant solution. Disinfectants may also be used to chemically treat infectious hospital waste, especially the disposable plastic and microbiological wastes [1].

Many hospitals are still using phenolic disinfectants, while their use is being discouraged throughout advanced countries. Toxicity issues have led to discontinued use of gluteraldehydes in some developed countries [2] but, in developing countries, they are used very frequently.

The standard tests to check disinfection efficiency include Rideal-Walker phenol coefficient (R.W.C) test [3], Chick-Martin and Garrod's test [4], Kesley and Maurer's in-use tests, capacity use dilution test by Kelsey and Sykes [5] and various other microbial time kill assays [6].

Phenolic compounds are relatively tolerant of anionic and organic matter. They are absorbed by rubber and plastics and leave a residual film. This residual film may cause irritation to the skin [7]. A collaborative study by Rutala and Cole documented the facts that randomly selected Environmental Protection Agency (EPA) registered phenolic detergents and quaternary ammonium compounds do not consistently meet the manufacturer's bactericidal label claims [8].

Phenol compounds at concentration of 2-5% are generally considered bactericidal, tuberculocidal, fungicidal and virucidal against lipophilic viruses [9]. The aim of this study was to evaluate the efficacy of the phenolic disinfectant used in hospitals in Kogi state by standard methods.

MATERIALS METHODS

Samples of Dettol and Izal purchased for use collected from randomly selected hospitals in Kogi state were evaluated for potency by standard methods of Rideal-Walker, Chick-Martin and capacity use tests of Kelsey-Syke. The procedures were carried out at Specialist Hospital Lokoja between November 2011 and June 2012. Multi-resistant isolate of *Pseudomonas aeruginosa* was used as a test organism after testing for its minimal incubatory concentration (MIC) by plate method [10]. The disinfectants tested were:

- Izal (Manufactured by Rekitt and Colman Ltd.) contains Tar Phenol 7%
- Dettol (Manufactured by Reckit & Bencheizer Ltd.) contains Chloroxynol BPC 4.8% w/v

The tests below were carried out by standard procedures [11].

Rideal-Walker Test: To 5ml of each disinfectant dilution and phenol was added 0.2 ml of a 24h broth culture of *Pseudomonas aeruginosa*. At intervals of 2½ min, 5min, 7½ min, and 10 min, subcultures were made into 5ml of nutrient broth, using a standard wire loop. These were then incubated for 72h at 370 C after which the presence or absence of growth in each broth was recorded. The Rideal-Walker Coefficient was calculated by dividing the highest dilution of the disinfectant that killed in 5minutes but not in 10minutes by the highest dilution of phenol that kills in 5minutes but not in 10minutes.

Chick-Martin Test: A small quantity of human faeces was collected and dried in the sun for five days. Thereafter, 3g of the dry faeces was then dissolved in 100 ml of distilled water to give a 3%w/v suspension. Phenol solution (2%) was serially diluted 1:10 up to 1:100000. Similarly, all the disinfectants under test were serially diluted up to 1:100000. A 2.5 ml volume of each Phenol and disinfectant dilution was separately mixed with 2.5ml of the culture-faecal matter suspension (made up of 2ml of 24h broth culture + 48ml of 3% faecal suspension). After 30 min contact time, a standard loop-full of the disinfectant –culture – fecal matter mixture was transferred in duplicate to 10ml of broth and incubated at 370C for 48h; thereafter the presence or absence of growth was recorded. The Chick-Martin coefficient was calculated by dividing the concentration of phenol by the concentration of the disinfectant at which similar presence or absence of growth was recorded.

Capacity test of Kelsey-Sykes: At intervals of 0minutes ,10minutes, and 20minutes, 1ml of 24h standardized broth culture of *Pseudomonas aeruginosa* was added to 3ml of each disinfectant (Bleach, Dettol, Izal, Purit) respectively, diluted at approximately the dilutions recommended for use by the manufacturer. After a contact time of 8min, 0.2ml of the disinfectant/*Pseudomonas aeruginosa* mixture was transferred to 9ml of sterile peptone broth in five replicates. The peptone broth contains 3% Tween 20 (Polysorbate 20). All inoculated peptone broth tubes were incubated at 370C for 48hrs after which all the tubes were examined for growth (turbidity) or no growth. Tubes showing growth were scored positive (+) while those without evidence of growth were score negative (-). Any disinfectant that scored two or more negative out of a set of five replicate recovery tubes, after the 1st and 2nd challenges was adjudged to have passed the test.

RESULTS

Disinfectants that are more effective than phenol have a coefficient >1. Those that are less effective have a coefficient <1 [11].

Table 1 shows the results obtained when dilutions of Izal were tested. At 1: 100 and 1: 200 dilutions, growth was recorded at 2½ minutes, but not at 5 minutes and above for both dilutions. At dilutions of 1:250, growth was observed at 2½ minutes and 5 minutes contact times, but not at 7½ minutes and 10 minutes contact times, thus giving a Rideal-Walker Coefficient of 2.5.

Disinfectant	Dilution of disinfectant	Contact time with culture (Minutes)			
		2½	5	7½	10
Izal	1:100	+	-	-	-
	1:200	+	-	-	-
	1:250	+	+	-	-
	1:300	+	+	+	+
	1:350	+	+	+	+
	1:400	+	+	+	+
Phenol	1:95	+	-	-	-
	1:100	+	+	-	-
	1:105	+	+	+	-
	1:110	+	+	+	-
	1:115	+	+	+	+

Table 1: Determination of Rideal-Walker coefficient for Izal and Phenol using *Pseudomonas aeruginosa* as test organism

+ Growth in the recovery medium, - No growth in the recovery medium, Rideal-Walker coefficient is 250/100 = 2.5

The result obtained, when dilutions of Dettol were tested are shown in Table 2. At 1: 100, 1: 200 and 1: 250 dilutions growth was recorded only at 2½ min and none at 5, 7½, and 10 min contact time. For dilution of 1: 300 growth was recorded at 2½ and 5 min contact times, but not at 7½ and 10 min contact times, thus giving a Rideal-Walker coefficient of 3.0

Disinfectant	Dilution of disinfectant	Contact time with culture (Minutes)			
		2½	5	7½	10
Dettol	1:100	+	-	-	-
	1:200	+	-	-	-
	1:250	+	-	-	-
	1:300	+	+	-	-
	1:400	+	+	+	+
	1:500	+	+	+	+
Phenol	1:95	+	-	-	-
	1:100	+	+	-	-
	1:105	+	+	+	-
	1:110	+	+	+	-
	1:115	+	+	+	+

Table 2: Determination of Rideal-Walker coefficient for Dettol and phenol using *Pseudomonas aeruginosa* as test organism

+ Growth in the recovery medium, - No growth in the recovery medium, Rideal-Walker coefficient is 300/100 = 3.0

The result for Chick-Martin Coefficient determination for Dettol, are shown in Table 3. At 1%, 0.9% and 0.81% there was no growth observed in the recovery media while growth was observed in the recovery media at concentrations of 0.73% and 0.66%, giving a Chick-Martin Coefficient of 2.0.

Disinfectant	Concentration (%)	Subcultures	
		1	2
Dettol	1	-	-
	0.9	-	-
	0.81	-	-
	0.73	+	+
	0.66	+	+
Phenol	2	-	-
	1.8	-	-
	1.62	-	-
	1.46	+	+
	1.31	+	+

Table 3 Determination of Chick-Martin coefficient for Dettol and phenol using *Pseudomonas aeruginosa* as test organism

+ Growth in the recovery medium, - No growth in the recovery medium, Chick-Martin coefficient for Dettol 1.54/0.77 = 2

The Chick-Martin Coefficient test for Izal shows ,that at 1%, 0.9% and 0.81% concentrations there was no growth observed in both recovery media, while at 0.73% and 0.66% growth was observed in both recovery media giving a Chick-Martin Coefficient of 2.0(Table 4).

Disinfectant	Concentration (%)	Subcultures	
		1	2
Izal	1	-	-
	0.9	-	-
	0.81	-	-
	0.73	+	+
	0.66	+	+
Phenol	2	-	-
	1.8	-	-
	1.62	-	-
	1.46	+	+
	1.31	+	+

Table 4: Determination of Chick-Martin coefficient for Izal and phenol using *Pseudomonas aeruginosa* as test organism

+ Growth in the recovery medium, - No growth in the recovery medium, Chick-Martin coefficient for Izal 1.54/0.77 = 2

The result obtained, for the Capacity test of Kelsey-Syke using *Pseudomonas aeruginosa* as the test organism are presented in Tables 5 and 6. Table 5 presents the result for Dettol under clean condition. At 1% concentration, all the tubes in the 1st challenge showed no growth while four and three tubes showed no growth in the 2nd and 3rdchallenge respectively giving a result of PASS. At 0.81% concentration three tubes and two tubes showed no growth in the 1st and 2nd challenges respectively with all the tubes in the 3rd challenge showing growth also giving an overall result of PASS. At 0.73%, all the tubes had growth with an overall result of FAIL.

The result for the test for Dettol under dirty condition is presented in Table 5. At 1% concentration, five, four, and three tubes showed growth in the 1st, 2nd and 3rd

challenges respectively thus giving a verdict of PASS. At 0.81%, two and one tubes showed no growth in the 1st and 2nd challenges while growth was obtained in all the tubes in the 3rd challenge equally earning a PASS. At 0.73%, all the tubes showed growth in all the challenges thus earning a verdict of FAIL.

Condition	Concentration (%)	Challenge number 1	2	3	Result
Clean	1.0	- - - - -	- - - - +	- - - + +	PASS
	0.81	- - - + +	- - + + +	+ + + + +	PASS
	0.73	+ + + + +	+ + + + +	+ + + + +	FAIL
Dirty (Addition of Feacal matter)	1.0	- - - - +	- - - + +	- - + + +	PASS
	0.81	- - + + +	- + + + +	+ + + + +	PASS
	0.73	+ + + + +	+ + + + +	+ + + + +	FAIL

Table 5 Kesley-sykes test for Dettol under clean and under dirty condition using *Pseudomonas aeruginosa*

Table 6 presents the result obtained for Izal under clean condition. At 2% concentration, all the tubes in the 1st an 2nd challenges showed no growth while four tubes showed no growth in the 3rd challenge with only one tube showing growth thus qualifying as PASS. At 1.5% concentration four tubes and two tubes showed no growth in the 1st and 2nd challenge respectively while one tube, three tubes and all the tubes showed growth in 1st, 2nd and 3rd challenges respectively thus earning a verdict of PASS. At 1% concentration, all tubes showed growth in the 1ss 2nd and 3rd challenges thus earning a verdict of FAIL.

Condition	Concentration (%)	Challenge number 1	2	3	Result
Clean	2.0	- - - - -	- - - - -	- - - - +	PASS
	1.5	- - - - +	- - + + +	+ + + + +	PASS
	1.0	+ + + + +	+ + + + +	+ + + + +	FAIL
Dirty (Addition of Feacal matter)	2.0	- - - - -	- - - - -	- - - - +	PASS
	1.5	- - - - +	- - + + +	+ + + + +	PASS
	1.0	+ + + + +	+ + + + +	+ + + + +	FAIL

Table 6 Kesley-sykes test for Izal under clean and under dirty condition using *Pseudomonas aeruginosa*

Table 6 presents the result obtained for izal under dirty condition. At 2 % concentration, all the tubes showed no growth for the 1st and 2nd challenges. Four tubes showed no growth in the 3rd challenge thus earning a verdict of PASS. At 1.5% four tubes and two tubes showed no growth for the 1st and 2nd challenges respectively while for the 3rd challenge, all the five tubes showed growth giving a verdict of FAIL.

Discussion

A wide range of disinfectants are available commercially that undergo extensive testing in controlled environments before market release. However, often, the products and procedures as described in the literature may not be able to adequately disinfect or decontaminate items when the surfaces have been contaminated with highly resistant or unusual organisms, or if the bioload of microorganisms is very heavy [1]. When choosing a disinfectant for specific hospital use, it may be necessary to know the expected number and the types of organisms likely to be present on the surface. It is critical that the disinfectant be selected based on its ability to be effective against the prevalent pathogenic microorganisms that can be transmitted by direct or indirect contact with the environment [6].

An ideal disinfectant should have a broad antimicrobial spectrum, should be non-irritating, less toxic, noncorrosive and inexpensive [12].

Many hospitals have always relied on manufacturers claim as to the efficacy of disinfectants purchased and used for surface disinfection and contaminated matter on healthcare facilities. The increase in microbial resistance to both old and new generation antibiotics have necessitated the regular check of disinfectant efficacy both when newly purchased before use and probably in use to reduce the risk of increased microbial load in the presence of disinfectant failure.

In the present study phenolic disinfectants newly purchased which are commonly used in our hospitals were evaluated for efficacy using *Pseudomonas aeruginosa* as test organism. The disinfectant coefficient observed in both methods compared favourably with standard phenol. Chick-Martin methods however, seemed to be more appreciated because the test simulates natural condition due to the addition of human faeces.

Although phenolic agents exhibit high toxicity and low biodegradability, they are still in use in developing countries because of their low cost. They are considered a health risk by the Environmental Protect Agency (EPA), and cannot be used in neonatal, paediatric ICU or on any infant contact surface. Eye irritation, contact dermatitis/utricaria and depigmentation of the skin have been linked to phenol residue contact [13].

Some researchers in India [1] observed that phenolics showed poor activity on rough surfaces that represent cracks and grooves on the floors and walls, very commonly seen in developing country health care settings. Therefore, better and safer disinfectants are required to replace them.

Some researchers [14,15] showed that antimicrobial

activities of disinfectants were concentration dependent. This observation will mean that if appropriate concentrations are not used even in the In-use testing they will be contaminations of disinfectants. Some other workers [16,17] all confirmed contamination of disinfectants in their different studies.

However, antiseptic compounds are still active against bacterial strains isolated from surgical wound infection despite increasing antibiotic resistance [18].

Disinfectants in constant and prolonged use gradually become contaminated thus raising the microbial load. The need to prevent this has been emphasized by some researchers [19].

It will be necessary to always evaluate new disinfectants before their application in the hospitals and also check same periodically in-use to ensure efficacy.

References

1. Singh M, Sharma R, Gupta PK, Rana JK, Sharma M, Taneja N. Comparative efficacy evaluation of disinfectants routinely used in hospital practice: India. Ind J Crit Care Med. 2012;16(3):123-129
2. BSG Guidelines for decontamination of equipment for gastrointestinal Endoscopy. BSG Working party Report. 2003. Available from: http://www.bsg.uk/pdf_word_do-cs/ disinfection.doc. [Last accessed]Accessed on April 01, 2008
3. Rideal S, Walker JT. The standardisation of disinfectants. J R Sanit Inst. 1903;24:424-41.
4. Garrod LP. A study of the Chick- Martin test for disinfectants. J Hyg (Lond). 1934;34:322-32.
5. Kelsey JC, Sykes G. A new test for the assessment of disinfectants with particular reference to their use in hospitals. Pharm J. 1969;202:607-609.
6. Kawamura-Sato K, Wachino J, Kondo T, Ito H, Arakawa Y. Correlation between reduced susceptibility to disinfectants and multi drug resistance among clinical isolates of *Acinetobacter* spp. J Antimicrob Chemother. 2010;65:1973-83
7. Widmer AF and Frei R. Decontamination and sterilization in manual of clinical microbiology 8th ed. Murray PR, Baron EJ, Jorgensen JH, Pfaller MA and Yolken RH. Asm Press washinton USA. 2003, Pp 88-89
8. Rutala WA, Cole EC. Ineffectiveness of hospital disinfectants against bacteria: a collaborative study. Infect control 1987;8:501-506.
9. O'Connor DO, Rubino JR. Phenolic compounds. In S.S. Block (ed.), Disinfection sterilization and preservation. Lea & Febiger, Philadelphia, Pa. 1991, pp 204-224.
10. Cruickshank R, Duguid JP, Marmion BP, Swain RHA. The Practice of Medical Microbiology Volume 2; 12th Edition, Churchill Livingstone Edinburgh and New York. 1980, pp193, 194, 299.
11. Hugo B, Russel. Evaluation of non-antibiotic antimicrobial agents In: Hugo, B. and Russel D. Pharmacological microbiology, 3rd Edition, Chapter 11, Blackwell Scientific publications, Washinton DC. 1983, pp237-254
12. Rutala WA, Weber DJ. Surface disinfection: Should we do it? J Hosp Infect. 2001;48:S64-8
13. Pierson J. Choosing a disinfectant for hospital environment. Indoor Environment connections. 2009;10. Available from: www.ieconnections.com/pdfs/newsletter/2009 /IEC-04-2009.pdf.
14. Awodele O, Emeka P, Agbamuche H, Akintonwa, A. The Antimicrobial activities of some commonly used disinfectants on Bacillus subtilis, *Pseudomonas aeruginosa* and Candida albicans. Afr J Biotechnol. 2007;6(8):887-990.
15. Okesola P, Abiola O, Olola O, and Aderonke F. The efficacy of the commonly used hospital disinfectants on *Pseudomonas aeruginosa*. Int Res J Microbiol. 2011;2(7):226-229.
16. Atoyebi OA, Niemogha MT, Odugbemi T, Oyewunmi OK. Bacterial pathogen isolated after surgical hand scrub at Lagos University Teaching Hospital. J Niger Infect Contr Assoc. 1999;2(1):19-23.
17. Niemogha MT. Nosocomial infections in surgical patients at Lagos University Teaching Hospital. Phenotypic and genotypic evaluation of Pathogens. Ph.D thesis. 2003;40-110.
18. Giacometti A, Cirioni O, Greganti G *et al*. Antiseptic compounds still active against bacterial strains isolated from surgical wound infections despite increasing antibiotic resistance. Eur J Clin Microbiol Infect Dis. 2002;21(7):553-556.
19. Oie S, Kamiya A. Microbial contamination of antiseptics and disinfectants. American Journal of Infection Control, 1996;24(5):389-395.